

Many of the Weather Bureau stations are located in cities in which there are one or more colleges. The Secretary has directed that at such stations, student observers be employed whenever by so doing, it is possible to economically perform the service of the Weather Bureau and at the same time permit poor, but ambitious boys to get a scientific education. * * * To-day there are about twenty-five young men in different subordinate capacities in the weather service who are thus working out their scholarships. * * * It is the lifting up from the lower to the higher strata of society, rather than the cultivation of a few favored ones at the top, that inures to the homogeneity and welfare of the people.

NOT BALL LIGHTNING.

The April number of the Climate and Crop Report for Virginia publishes an interesting case of lightning, described by Mr. G. E. Murrell at Colemans Falls, now Fontella, Bedford Co., Va.

Although this lightning is described as a globe, six or eight inches in diameter, traveling from northeast to southwest horizontally, at about 100 feet above the earth, and diminishing in size as it passed through three locust trees successively, yet the Editor notes that the characteristic feature of ball lightning, viz, its very slow motion and its eventual explosion at the end of its journey, without doing much damage, were all absent, and we must hesitate to consider this as a well authenticated case of genuine ball lightning.

EMPIRICAL GENERALIZATIONS FOR SOUTH CAROLINA.

Attention has been called to the fact that—

In South Carolina on April 5 snow and ice occurred in that State, the snow being confined to the northern border counties. It is a coincidence worthy of notice that in the cold year of 1835 snow fell in April also. It undoubtedly takes more than two so widely separated years to establish a rule, but nevertheless the fact is worth remembering while sowing seeds of plants that are susceptible to cold, that when extremely low temperatures occur in February there are likely to be unusually cool periods in the two following months.

We have here what seems to be an excellent illustration of the ease with which empirical rules are framed without a very substantial basis. As we understand the above quotation, it says that occasionally snow and ice have occurred in April, and that, therefore, we may conclude that when extremely low temperatures occur in February there are likely to be unusually cold periods in March and April.

Of course this conclusion does not follow from the premises, and it would be interesting to know just what basis there is for it. Can not the author give us the details of an examination of many years instead of two?

RADIANT HEAT FOR THE PREVENTION OF FROST.

The April report of the California Section quotes an article by E. W. Holmes, of Riverside, Cal., who says that two or three years since the Messrs. Wright Bros., of Riverside, established a 35-horsepower boiler and a large quantity of pipe in order to supply steam to 3 acres of orchard. The steam was made to escape horizontally near the ground, and for each outlet there was a cloud of steam 10 feet long and 3 feet wide; one hundred such vents did the best work for these particular dimensions of boiler and orchard. The steam was turned on with a pressure of 40 pounds, but that would soon drop to 20 pounds. The temperature of the air was raised 3° F. whenever the steam was turned on. It was the heat produced and not the moisture thrown off that was efficacious. The coal consumed by such a system is no more than that used when burned in wire baskets for the purpose of raising the temperature of the air by the direct action of its

radiant heat. The production of moisture as a means of preventing frost effects has been a failure here in Riverside, though unquestionably the condensation of steam helps to overcome the cold. The blanket of cold air has no great depth in the valley, and by the use of many small fires it is possible to warm this cold stratum until all shall be of about the same temperature as at the tops of the trees.

Although there are times when the methods of smudging and of running water are useful, yet when we want to produce heat the simplest and least expensive process is the wire basket of burning coals. We have tried the method of crude oil and tar burning in sheetiron kettles; this method furnishes satisfactory heat cheaply, but the clouds of lampblack are so injurious that it is generally discarded. We have tried the raising of the dew-point sufficiently to prevent frost by the evaporation of water into immense quantities of steam; we have tried shallow vats for boiling water, but this method was also insufficient.

When 20 to 40 baskets of soft coal per acre were burned, the temperature was raised from 3° to 5°, or possibly more, and this change of temperature was sufficient. In one orchard a lathe screen was built but the cost was nearly \$400 per acre. The method of piping steam through the orchard has been explained above. The most popular system is the burning of coal in a basket, which costs about \$4 per acre for the baskets, and \$2.50 per night for the coal. The replenishing of the baskets for the second night and the lighting of them is the principal item of labor.

THE PRESENT STATE OF LONG RANGE FORECASTING.

In the Nineteenth Century for March, 1899, pages 418-423, Kropotkin reviews the present state of daily weather forecasting and the possibility of responding to the general desire for predictions of the coming weather several days, if not weeks and months, in advance. He briefly considers the two methods most commonly studied, with a view to laying the basis for such long range predictions, viz: (1), the determination of cycles or periods of recurrence of hot and cool; dry and wet weather; (2), the study of the different types or spells of weather, their duration, and the order of succession in which they follow each other.

Kropotkin enumerates as established, or at least plausible, the so-called 11-year, or more properly, sunspot periodicity in temperature, rainfall, storms, etc; the 35-year period of Brückner; the lunar latitude periods of A. Poincaré and other French students; the 19-year, or nutation period of H. C. Russell; the 7-year period of Murphy; the 26.68-day period of Professor Bigelow; the 5.5-day period of Mr. Clayton; the cold waves of May; the nine alternations of heat and cold annually, as indicated by Mr. Buchan, and the three short periods indicated by Mr. Lamprecht. He concludes that the knowledge of these many waves will certainly be very helpful for long period weather forecasts.

Again, with regard to types of weather, Kropotkin enumerates the system of long period forecasts evolved in India by Blanford and Eliot, in which the probable strength and character of the monsoon rains of summer and the dry monsoon of winter is foreseen several months in advance; also the system evolved in Oregon by Mr. B. S. Pague, forecast official of the Weather Bureau, in which the coming summer weather is predicted in the spring and the winter weather predicted in the autumn; also the results of the studies of Abercromby and van Bebber, who discriminate five distinct types and five subtypes of weather which have a tendency to prevail at certain seasons, to be maintained for several days in succession, and each to be followed by some other specific type.

He states that "some modest attempts at forecasting

weather a few days ahead are already made, and we find them in the shape of hints at the end of the daily meteorological summaries of weather." In this paragraph we assume that Prince Kropotkin refers to the work done by European weather bureaus, he probably has overlooked the fact that in the United States predictions have been made by the method of types, as well as by the study of sequences and by the deductive meteorological theories, with systematic regularity for one day, and, whenever possible, for several days in advance, ever since 1869. During the current month of April, 1899, in fact, Prof. E. B. Garriott has made such predictions for forty-eight hours in advance without exception, daily, for all the States east of the Rocky Mountains, whereas in previous years it has generally been considered allowable to omit the 48-hour predictions and confine one's self to the 24-hour prediction whenever the former seemed rather uncertain of fulfilment. In conclusion, Kropotkin states that a knowledge of the general circulation of the atmosphere, at a given moment, is the one thing needed as a foundation for better predictions and that to achieve this the meteorological stations on mountain tops, the cloud observations, the balloon ascensions, and the American kite methods, must be utilized and he promises a future article analyzing the results of this class of work.

The great interest in the subject of long range predictions of the weather and of the season is shown by the numerous quotations from Kropotkin's article that are going the rounds of the daily press and the monthly reports of the climate and crop sections. Each commentator favors some special view of the subject. Our summary of Kropotkin's article given in the preceding paragraphs shows that he does not commit himself to any theory, nor critically examine the reliability or value of any periods that have been announced from time to time. He merely states that we have the two methods of approaching the subject by cycles and by types, and that hereafter he will publish something relative to the bearing of observations at high level on this problem.

Several commentators have quoted Kropotkin as especially indorsing the so-called sun spot cycle in the following paragraph:

It is now certain that the number and the size of the dark spots which we see on the surface of the sun are in some way connected with the weather that we have on the earth.

This statement by Kropotkin seems to the present writer altogether too positive, although it is intended to be quite guarded. It is quite plausible that the variations in the sun spots have some general relation to the temperature and radiation of heat from the sun's surface, although the observations of solar radiation have not yet demonstrated this. It is quite plausible that if the solar radiation varies, then we should experience a corresponding variation in the temperature of the earth's surface and the air. It is true that observations of deep soil temperatures have shown some relation of this kind. It is true that K ppen made it appear plausible that an increase of temperature in the equatorial regions follows the formation of many spots on the sun and that a diminution of temperature in the north temperate zone also followed the same event, whereas the general effect upon the whole earth is masked by the influence of currents of air and the formation of clouds. In November, 1870, the present writer published a short article in Silliman's American Journal of Science in which it seemed to be clearly shown that an increase in the number of spots gave a decrease in the amount of heat received on the summit of the Hohenpeissenberg from the sun. But these and similar computations deal only with annual means of sun spots and atmospheric temperatures. They are equivalent to the assertion that if the mean amount of spotted area on the sun's surface slowly increases from

zero up to its maximum value, there is a corresponding slow diminution of about 1° Reaumur, or in an extreme case, possibly 3° Fahrenheit, in the temperatures observed at the ground. Such a statement is equivalent to a long range forecast as to the general average temperature of a whole year, but it tells us nothing with regard to special seasons or daily local weather or the weather of the whole globe for a given day. It gives us no long range rules for weather, but only for the most general climatic conditions as to temperature. It gives us no power of forecasting until we can forecast the spottiness of the sun. Similar computations have been made with reference to rainfall, hail, auroras, cloudiness, thunderstorms, cyclonic storms, the direction of the winds, and other phenomena, but all variations in these latter are results of complex physical processes following the changes in solar radiation. So long as the atmospheric processes are little understood, or not at all, it must be hopeless to handle such forecasts. There is at present no immediate prospect that we shall be able to make long range forecasts based on the condition of the sun's spots.

The study of the subject may be worthy the best efforts of those physicists who, like Professor Langley, are in a position to investigate in detail, the action of the solar radiation upon the earth and its atmosphere. But for the present, the ordinary observers and readers, the progressive inventors, and the enterprising financiers, must not allow their hopes to be raised too high by the ready pens of those who substitute brilliant inventive genius for the solid knowledge that can only come by slow and thorough investigation.

CHARACTERISTICS OF TORNADOES.

Although the Weather Bureau utilizes every opportunity of obtaining reliable descriptions of tornadoes and hopes to even get reliable photographs, yet our progress in that direction is very slow. It is very rare that a cool-headed observer, with sketch book and pencil, notes the phenomena as they are actually present before him. Too much is left to memory and verbal description. The tornadoes of April 27, of which at least four occurred in Missouri, have added to our stock of illustrations a few points that are not always clearly brought out. All of these moved from the southwest to the northeast. With regard to the one at Avalon, Prof. A. W. Baker states that—

It passed about ¼ mile east of him. It was perfect in form, with a complete funnel extending to the earth. The whirl was from left to right and the path from 100 to 200 yards wide. The path of destruction was about 8 miles long. Light rain and small hail fell just before its passage, and it was followed by heavy rains. There was very little lightning or thunder. The tornado seemed to form at the lower corner of the cloud in the southwest.

The Kirksville tornado had a path of 1,300 feet in extreme width; the path of total destruction was from 600 to 1,000 feet wide; "the whirling motion was from right to left, or counter clockwise." This is rather obscure; from left to right would be counter clockwise. As one stands facing the north the sun passes from the east or right hand behind one's back to the west or left hand. This is clockwise. The earth rotates in the opposite direction, or counter clockwise. If an ordinary watch were laid upon the ground at the North Pole, its hands would rotate in a direction opposite to that of the earth, and this would be clockwise. An ordinary low pressure storm has its winds revolving counter clockwise, and this rule is also almost invariable with respect to tornadoes. Mr. E. L. Dinniston, of Kirksville, who was directly in its path, says:

A short time before 6 p. m. a funnel-shaped cloud was seen to form high in the air about 12 miles southwest of Kirksville. For a short time it hung almost motionless and then the short funnel seemed to